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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

T.M.42

THE 1000 HP TRAFFIC AIRPLANE OF THE ZEPPELIN WORKS IN STAAKEN.

By

A. K. Rohrbach.

Translated from
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This monoplane, made entirely of duralumin, attained a speed of 211 km. (130 miles) per hour in its trial flights, with slightly throttled engines.

In the period from May, 1919, to September, 1920, the Zeppelin Works at Staaken built a swift traffic airplane, designed by myself, equipped with four 260 HP Maybach engines (Figs. 2 to 4). Its empty weight is 6072 kg., which could be considerably reduced in building another on the basis of present experience. With a total weight of 8500 kg., the airplane has the exceptionally high wing loading of 80 kg/m², while the load per HP is 8.5 kg. (18.7 pounds). The speed of the airplane was 211 km/hr. at 100 r.p.m. below the full r.p.m. of the engine. The four identical engine units are entirely independent of each other and completely separated from the central fuselage occupied by the passengers and crew. The engines rest on strong duralumin brackets (Figs. 5 to 7) at the front edge of the wings, each engine driving a propeller directly, whereby the high speed insures satisfactory efficiency. On the carburetor side of each engine there is a space in the engine nacelle from which a mechanic, fully protected from the slip stream, can watch the engine and remedy slight troubles. The en-

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gines can be reached during flight through a passageway inside the wing (Fig. 6). In this passageway are the aileron and carburetor controls, as also the gasoline pipes. It is amply ventilated and warmed by the heat from the engines and facilitates communication between the members of the crew, since the noise of the engines is greatly deadened. The fuel tanks, holding sufficient fuel for six hours' flight at full power, are fastened in the wings, in completely isolated and well ventilated compartments (Figs. 8 to 11), on strong, rigid, hollow supports with intervening layers of felt. The tanks are ventilated by pipes leading to the lower side of the wings. The fuel runs out of the tanks under the action of gravity into small storage tanks, fastened to the engine supports near the crank case, and is thence pumped into the overflow carburetor.

The wings, fuselage, tail unit and engine supports are made of duralumin. The stresses to be withstood by these members are distributed by the metal covering, which is provided with riveted strengthening strips. The outer surface is thus made so strong that, in the event of repair work on the airplane, important structural members cannot be readily injured by local stresses. The main part of the wing is formed by a strong box girder a (Fig. 3). This girder is strengthened by three full-length spars b and a larger number of sheet-metal partitions c. These transverse and longitudinal members are riveted to the top and bottom of the wing throughout its whole length, either by means of flanges

or angle pieces (Fig. 6). To the front and rear sides of the box girder are attached lattice ribs, some covered with thin sheet metal and some with linen fabric. The thickness of the sheet metal parts of the boxgirders, as likewise that of the angle pieces and rivets, varies between 0.6 mm. and 3 mm., according to the different stresses to be withstood. In order that the covering may not buckle between the spars, hollow inside girders d (Fig. 7) are riveted throughout the entire span.

Contrary to present experience, there was at first some uncertainty regarding the probable stresses on the members of the box girder employed for stiffening the wing. In order, therefore, to assure the structural safety of the first airplane, two lift cables were added under each wing, so attached that the bending moments in the wing girders are offset as much as possible. These cables give the wings an exceptionally large coefficient of safety during flight. They exert a favorable influence even on the ground and in landing. In no case has any slackness of these cables been observed.

The wings have a surface area of 106 square meters, a span of 31 meters, and an average thickness of only 0.6 meter. With reference to the mean chord, the monoplane has an aspect ratio of 1 : 9.1, while hitherto the ratios have usually been between 1 : 5 and 1 : 6.5. This favorable aspect ratio lessens the drag so much that the total drag, including that of the lift cables, is still less than that on other monoplanes with no outside stays. Consequently, the lift-drag ratio of the whole airplane is

1 : 11.5, a value probably not hitherto attained by any other airplane.

The fuselage is strengthened by the bulkheads e (Fig. 3), whose outer flanges are riveted directly to the outer shell. The two bulkheads which unite the wings and fuselage are especially strong (See Fig. 1).

The two pilots sit beside each other in the front part of the fuselage above the passengers, the control levers for both pilots being coupled together. The throttle and ignition switch are not duplicated. Provision is made for 12 passengers, but 18 can be carried on short flights. The toilet rooms are in the rear, as likewise rooms for the mail, baggage and radio instruments. The extreme front room is only open to the passengers during flight, as it is intended for protection in difficult landings on unfavorable ground.

The tail unit is based on the horizontal stabilizer or tail plane attached to the fuselage. This stabilizer is stiffened, like the wings, by a box girder. On the contrary, there are three vertical lattice girders inside the fin. Both elevator and rudder are compensated. The stability of the airplane is such that only very small forces and very small movements of the rudder and elevator are required. In designing the tail unit, it had to be taken into consideration that, on account of the high wing loading, the tail unit loading would differ from the hitherto customary loading more than 100%. For, since the attacking angles of the tail surfaces are independent of the wing loading but the speed is consid-

erably greater, the tail unit has, with greater wing loading, likewise to withstand greater forces per surface unit.

Special care must be exercised in the construction of the landing gear on account of the high lifting speed of 110 km/hr, and landing speed of 130 km/hr. In contrast with the many wheeled landing gears of most large airplanes, it has only two wheels, each with a double rim 1500 x 200 mm. Each wheel is held in position by three streamlined steel struts (Figs. 2 and 4). On either side of the body, two of these struts constitute an approximately horizontal plane linked to the lower edge of the fuselage, the rear one serving as wheel axle, while the third strut, supporting the axle against a reinforced portion of the wing, consists of two telescoping tubes containing a strong spiral spring. These supporting points are so selected that, the least possible stresses will be exerted upon the wing in alighting. The simplicity of this statically determined landing gear gives it sufficient strength, with relatively small weight. Contrary to previous custom, the springs have no permanent compression, which would cause disagreeable and dangerous jumps in too sudden landings.

As might be expected in using springs without permanent compression and with a play of 300 mm. (in contrast with 100 to 150 mm. for springs with permanent compression), the landing takes place smoothly and without jumps, in spite of the high speed. As the speed decreases, the load is transferred without much bumping from the air to the wheels and ground, with a run of only 150 to 200 meters.

For airplanes of like size, the dangers of landing with this new landing gear, with a speed of 110 to 130 km/hr., are only about as great as landing at 70 to 80 km/hr., with a spring having permanent compression and less play. Should the performance of this airplane in long flights equal that in the trial flights, the load could be increased from 35-50 to about 80 kg/m^2 and the speed could then be considerably increased.

(Translated by National Advisory Committee for Aeronautics.)

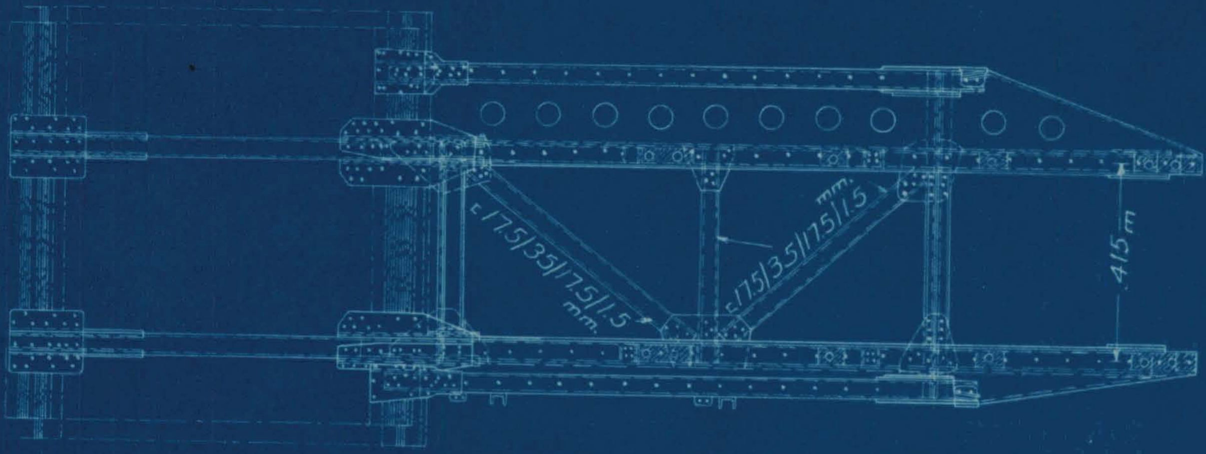


Fig. 7

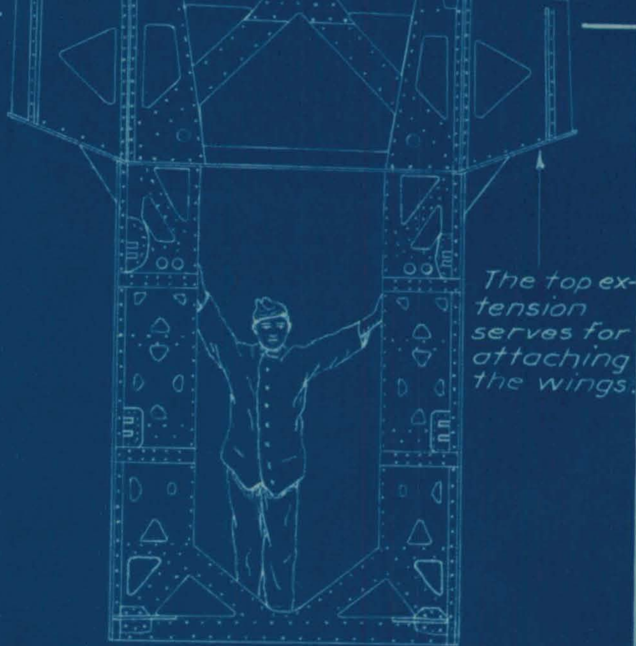
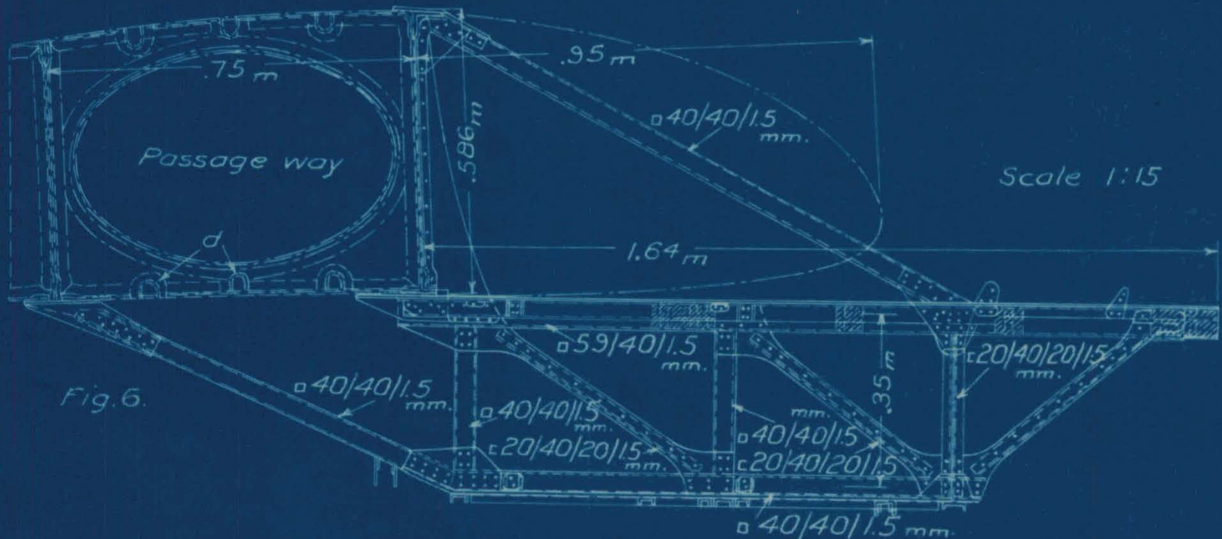


Fig. 1. Bulkhead of fuselage



Scale 1:15

Fig. 6.

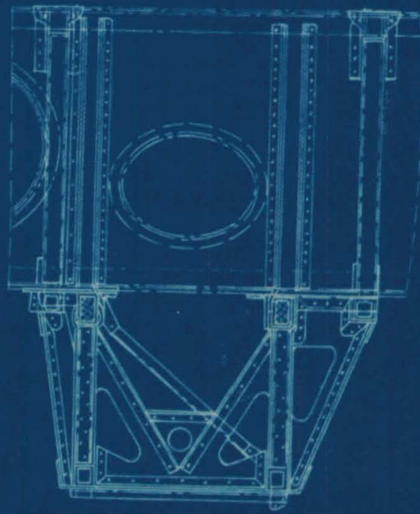


Fig. 5

Figs.-5-6-7. Left inner engine support.

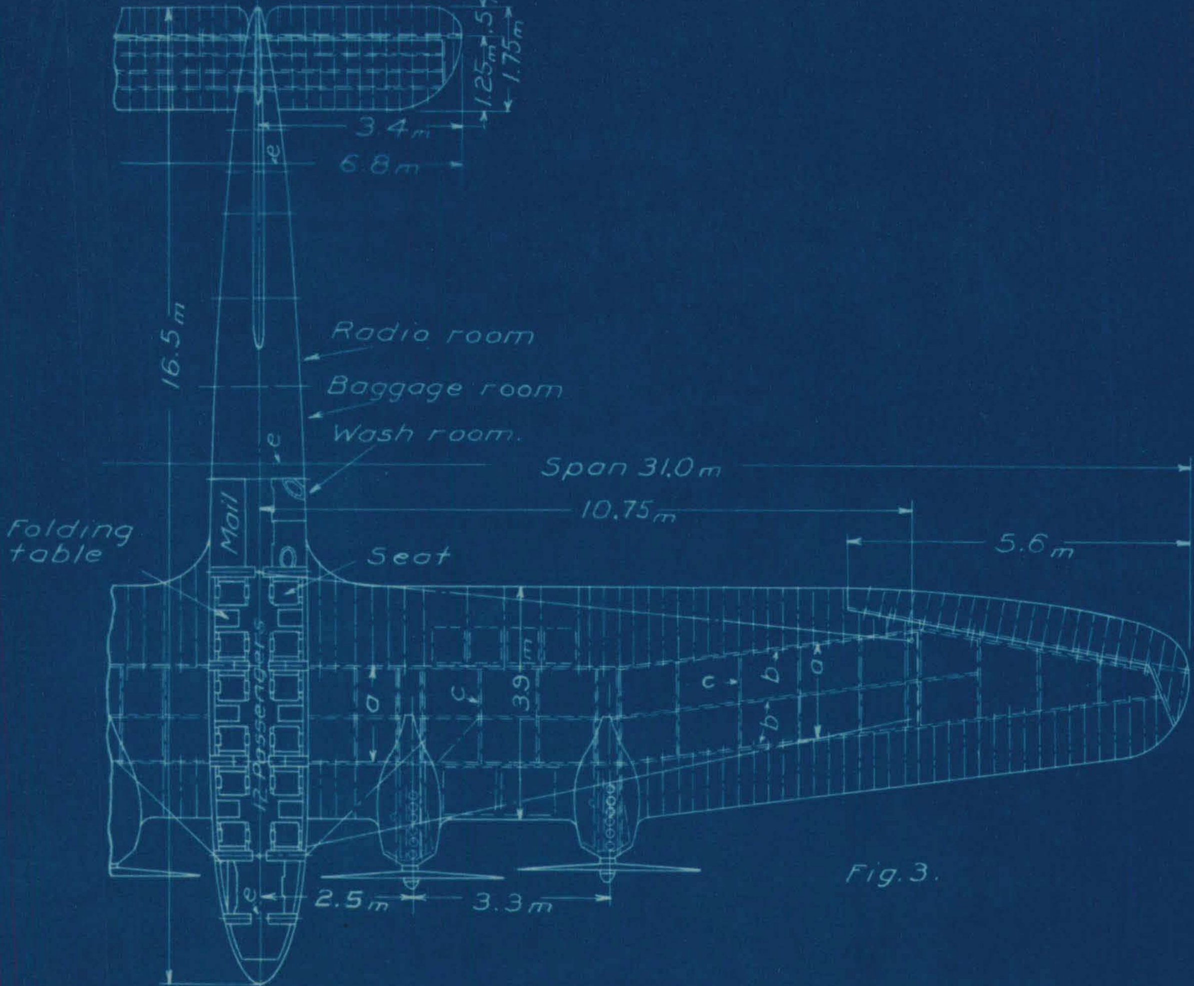


Fig. 3.

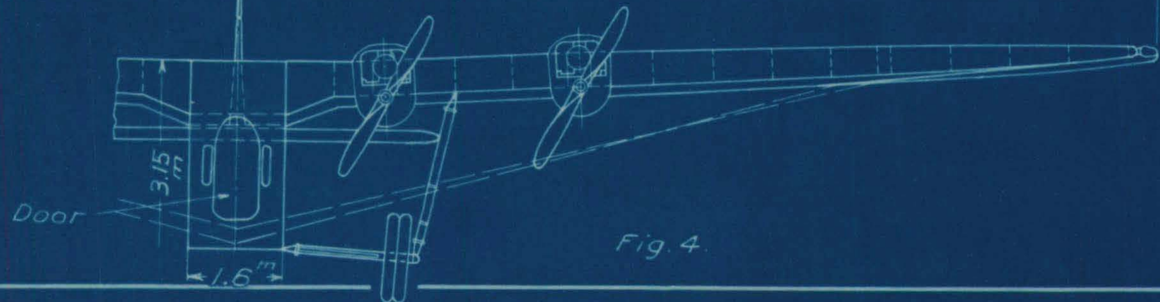


Fig. 4.

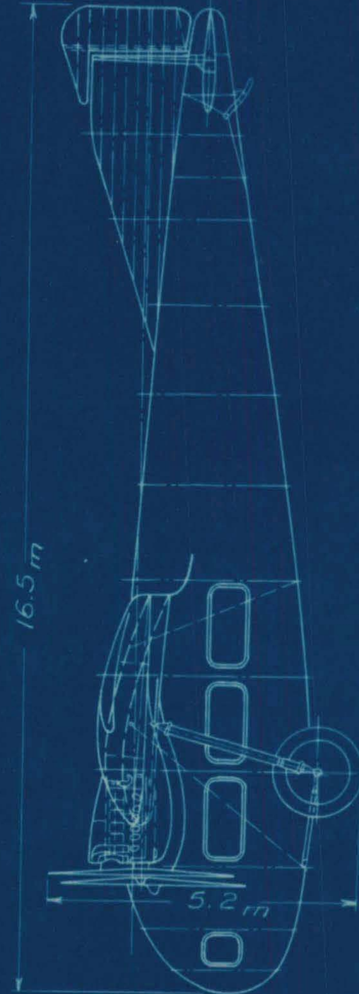
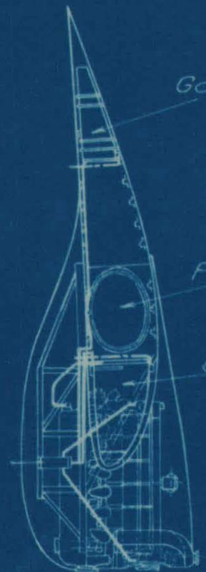


Fig. 2.

Scale 1:125



Section C-D
Fig. 11.

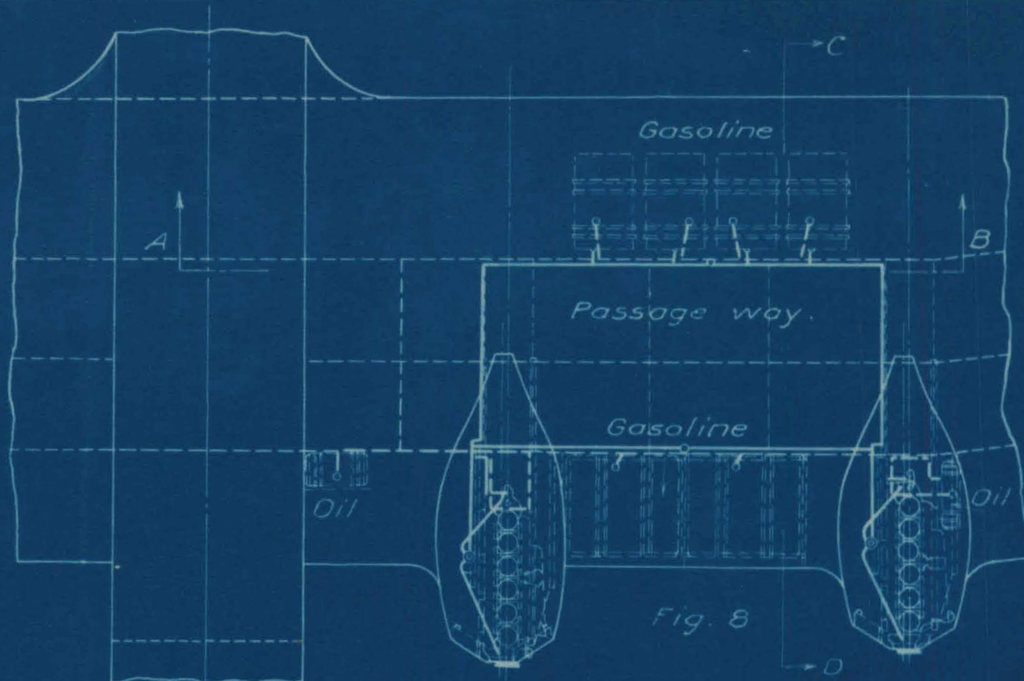


Fig. 8

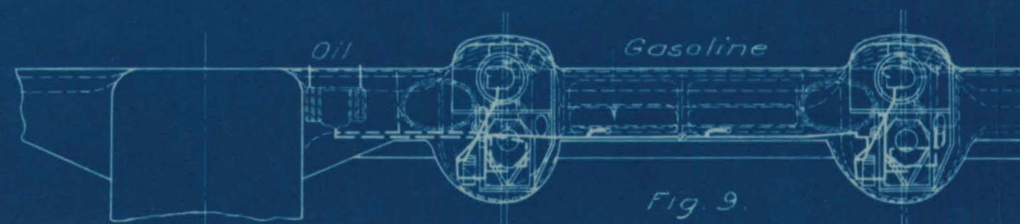
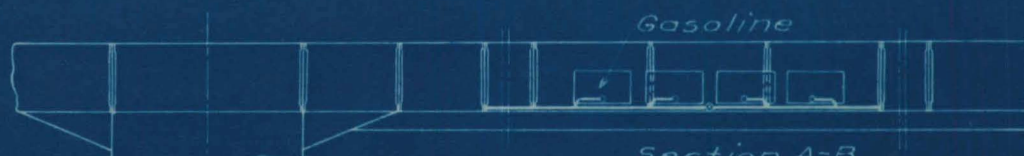


Fig. 9.



Section A-B
Fig. 10

Arrangement of engines
and gasoline tanks.